Measure: Intersection Roundabouts (T13)

Plan, design and construct three roadway roundabouts in lieu of signalized intersections at candidate locations with the most favorable traffic and site characteristics based on successful roundabout projects elsewhere in the region or State.

Emission reduction potential by 2020:	987 tCO_2e / yr.
Percentage of goal (2012):	NA
Percentage of goal (2020):	.04%
Total annual average implementation costs:	0
Entity that bears the costs of implementation:	NA
Cost/Savings per tCO_2e:	Savings $1254 / tCO2e
Net annual savings:	$0.495 million
Entity that realizes the financial return:	Tucson motorists (99.6%) and City of Tucson (0.4%)
Equitability (progressive/regressive, income/revenue neutral, etc):	Likely progressive since fuel savings are a higher % of lower income household disposable income.
Potential unintended consequences:	Initial resistance

Background information:

The modern roundabout is a circular intersection with design features that promote safe and efficient traffic flow. At roundabouts in the United States, vehicles travel counterclockwise around a raised center island, with entering traffic yielding the right-of-way to circulating traffic. In urban settings, entering vehicles negotiate a curve sharp enough to slow speeds to about 15-20 mph.

Within the roundabout and as vehicles exit, slow speeds are maintained by the deflection of traffic around the center island and the relatively tight radius of the roundabout and exit lanes. Slow speeds aid in the smooth movement of vehicles into, around, and out of a roundabout. Drivers approaching a roundabout must reduce their speeds, look for potential conflicts with vehicles already in the circle, and be prepared to stop for pedestrians and bicyclists. Once in the roundabout, drivers proceed to the appropriate exit, following the guidance provided by traffic signs and pavement markings.

Roundabouts are appropriate at many intersections, including high crash locations and intersections with large traffic delays, complex geometry (more than four approach roads, for example), frequent left-turn movements, and relatively balanced traffic flows. Roundabouts can be constructed along congested arterials, in lieu of road widening, and can be appropriate in lieu of traffic signals at freeway exits and entrances.

Roundabouts are not appropriate everywhere. Intersections that may not be good candidates include those with topographic or site constraints that limit the ability to provide appropriate geometry, those with highly unbalanced traffic flows, and isolated intersections in a network of traffic signals.

Status Quo / Business as Usual:

Absent a proactive policy to begin adding roundabouts beyond the few which are now in place or planned, Tucson motorists will miss opportunities for sharing the multiple co-benefits (energy and emissions savings, cost savings, improved productivity, increased safety, etc.) of roundabouts compared to signalized intersections.

Description of Measure and Implementation Scenario:

In the Tucson area, three roundabouts have been proposed along the Silverbell Road improvement project, at the intersections of Grant Road, Ina Road, and Ruthrauf Road. This measure consists of three additional roundabouts either to replace existing intersection controls or to substitute for conventional intersection designs in new or significantly modified intersections in the first implementation year (may depend on requirements of TDOT/ADOT design and construction schedules).

Has the Measure been implemented elsewhere and with what results:

The first modern roundabouts in the United States were constructed in Nevada in 1990. Since that time, although a precise number is not available, approximately 2,000 have been built. By comparison there are about 20,000 roundabouts in France, 15,000 in Australia, and 10,000 in the United Kingdom.

Thirty-one States in the U.S. have active programs to construct roundabouts.[1] Three years ago, Arizona had two roundabouts, now it has around 17, with 23 more under construction according to the Arizona Department of Transportation. Modern roundabouts in New York tripled since 2006, from 16 to 53.[2]

Several studies conducted by the Insurance Institute of Highway Safety and others have reported significant improvements in traffic flow following conversion of traditional intersections to roundabouts. A study of three intersections in Kansas, Maryland, and Nevada, where roundabouts replaced stop signs, found that vehicle delays were reduced 13-23 percent and the proportion of vehicles that stopped was reduced 14-37%.[3]

A study of three locations in New Hampshire, New York, and Washington, where roundabouts replaced traffic signals or stop signs, found an 89 percent average reduction in vehicle delays and a 56 percent reduction in vehicle stops.[4]

A 2005 Insurance Institute study documented missed opportunities to improve traffic flow and safety at 10 urban intersections suitable for roundabouts where either traffic signals were installed or major modifications made to signalized intersections.[5] It was estimated that the use of roundabouts instead of traffic signals at these 10 intersections would have reduced vehicle delays by 62-74 percent. This is equivalent to approximately 325,000 fewer hours of delay on an annual basis.

Energy/Emission analysis:

A Washington State Department of Transportation study determined that one gallon of fuel is saved per 365 vehicles moving through a roundabout per day.[6] Applying this average to three planned roundabouts along Silverbell Road from Grant Rd. to Ina Rd results in a gasoline savings of 109,000 gallons/year based on projected traffic flows.[7]

A second opportunity for energy savings occurs n the elimination of electrical service to stoplight and pedestrian signals. For the three roundabout locations noted above, and using Energy Star criteria for signalization, the estimated energy savings from substitution of traffic signals with roundabouts is approximately 19,450 kWh / year.[8]

Thus, for every three roundabouts installed in lieu of traffic signals at locations with traffic flows similar to those in the proposed Silverbell Road improvement project, there is an energy savings of 109,000 gallons of gasoline and 19,450 kWh of electricity per year.

Over a one-year period with the energy savings identified above for a three-roundabout project, the GHG emission reductions attributable to the project will be:

> 109,000 gallons / year x CO2 emissions / gallon of vehicle fuels (93% gasoline; 7% diesel) = 969 tCO2e / year.
> 19,450 kWh / year x 2.0 pounds / kWh = 17.6 tCO2e / year.
>
> TOTAL: 987 tCO2e / year

Assuming that this initiative does not begin to realize benefits until after 2012, we project eight years of cumulative savings through 2020 of 7,896.

Climate Change Impact Summary (in tCO_2e):

COT 1990 Citywide GHG emissions (baseline):	5,461,020
MCPA 7% reduction target for COT:	5,078,749
2012 BAU GHG emissions projection:	7,000,000
2020 BAU GHG emissions projection:	7,343,141
GHG emissions reduction to meet 7% goal (2012):	1,921,251
GHG emissions reduction to meet 7% goal (2020):	2,264,392
Contribution of this Measure in 2020:	987

Economic analysis:

The safety, operational, and environmental benefits of specific roundabouts can be quantified and compared to the initial construction and ongoing maintenance cost over the life cycle of the roundabouts. While initial construction costs might be higher for a roundabout in a retrofit situation (construction costs are often comparable to signalized intersections in new installations), the roundabout's ongoing maintenance is often cheaper than for signalized intersections, as there is typically no signal hardware to power, maintain, and keep current in terms of signal timing.

Finally, while many factors influence the potential service life of a roundabout (types of construction materials, weather conditions, traffic conditions, growth in the area, etc.), roundabouts can often serve for longer periods of time between major upgrades (repaving, reconstruction, etc.) than comparable signalized intersections.[9]

In a report covering roundabout construction in Alaska, results found that modern roundabouts are usually less expensive than traffic signals. Roundabouts did not require expensive signal equipment or maintenance of that equipment. In Anchorage, the initial construction cost of a roundabout was approximately equal to the initial construction cost of a signal. However, maintaining signals costs Anchorage taxpayers approximately $15,000 per year for each signal. Over the long run, modern roundabouts proved much less expensive than traffic signals.[10]

An example based on the 3-Roundabout Silverbell Road Improvement Project: Cost of roundabouts v. cost of signalization:

> We assume construction cost parity between planned roundabouts and a signalized intersection alternative. Therefore, there is no net cost per ton of GHG reduced.
>
> a) Fuel cost savings to drivers: 109,000 gallons x 20 years x Tucson fuel prices 2013-2032 (projected by Westmoreland Associates) are: $9.86 million, or an average of $493,000 / yr.[11]
>
> b) Electricity cost savings to the City Department of Transportation CDOT: 19,450 kWh/year x TEP rate for traffic signal electricity[12] = $36,000 or an average of $1800 / year.
>
> **Total Economic Benefit: $9.9 million over 20 years, not including auto accident reduction costs and productivity benefits from reduced congestion.**

The savings per tCO2e is $9,900,000 divided by 7,806 = $1254.

The benefits accrue to the City in the form of electricity savings, and to drivers in fuel savings. Assuming a multiplier effect of 1.5, the positive economic impact of this measure over 20 years is estimated at $14.85 million.

Co-benefits:

Several features of roundabouts promote safety. At traditional intersections with stop signs or traffic signals, some of the most common types of crashes are right-angle, left-turn, and head-on collisions. These types of collisions can be severe because vehicles may be raveling through the intersection at high speeds.

With roundabouts, these types of potentially serious crashes essentially are eliminated because vehicles travel in the same direction. Installing roundabouts in place of traffic signals can also reduce the likelihood of rear-end crashes and their severity by removing the incentive for drivers to speed up as they approach green lights and by reducing abrupt stops at red lights. The vehicle-to-vehicle conflicts that occur at roundabouts generally involve a vehicle merging into the circular roadway, with both vehicles traveling at low speeds – generally less than 20 mph in urban areas.

A 2001 Insurance Institute study of 23 intersections in the United States reported that converting intersections from traffic signals or stop signs to roundabouts reduced injury crashes by 80 percent and all crashes by 40 percent.[13]

Similar results were reported in another study: 75 percent decrease in injury crashes and a 37% decrease in total crashes at 35 intersections that were converted from traffic signals to roundabouts.[14] When safety factors go up, societal costs generally decrease.

Another co-benefit of roundabouts is that they can enhance roadway aesthetics by providing landscaping opportunities.

Lost driver productivity would be significant, based on the Insurance Institute example above, and suggests a savings of 32,500 driver-hours annually per roundabout.[15]

Equitability:

This measure is neutral in its costs and benefits to drivers of all income categories from the standpoint of fuel savings. Benefits of reduced delays will also be shared equally among all roadway users.

Potential unintended consequences:

Drivers may be skeptical, or even opposed, to roundabouts when they are proposed. However, experience demonstrates that driver opinions change quickly once they become familiar with roundabouts. An Insurance Institute study in three communities where single-lane roundabouts replaced stop-sign controlled intersections found 31 percent of drivers supporting the roundabouts before construction compared with 63 percent shortly after.[16]

Another study surveyed drivers in three additional communities where roundabouts replaced stop signs or traffic signals.[17] Overall, 36% of drivers supported the roundabouts before construction compared with 50% shortly after.

Follow-up surveys conducted in these six communities after roundabouts had been in place for more than one year found the level of public support increasing to about 70% on average.[18]

Endnotes

[1] Insurance Institute for Highway Safety. http://www.iihs.org/research/qanda/roundabouts.html

[2] "Green." The New York Times, December 30, 2008. http://green.blogs.nytimes.com/2008/12/30/roundabouts-efficient-or-annoying/?scp=1&sq=roundabouts%202008&st=cse

[3] Retting, R.A. Luttrell, G.; and Russell, E.R. 2002.Public opinion and traffic flow impacts of newly installed modern roundabouts in the United States. ITE Journal 72:30-32, 37.

[4] Retting, R.A.; Mandavilli, S.; Russell, E.R.; and McCartt, A.T. 2006. Roundabouts, traffic flow, and public opinion. Traffic Engineering and Control 47:268-72.

[5] Bergh, C.; Retting, R.A.; and Meyers, E.J. 2005. Continued reliance on traffic signals: the cost of missed opportunities to improve traffic flow and safety at urban intersections. Arlington, VA: Insurance Institute for Highway Safety.

[6] "Hot or Not: Roundabouts." The New West Magazine. February 11, 2008.

[7] http://dot.ci.tucson.az.us/projects/stone/pdfs/roadimp.pdf

[8] http://www.energystar.gov/ia/partners/product_specs/eligibility/traffic_elig.pdf

[9] "Roundabouts: Technical Summary." Federal Highway Safety Administration. Office of Safety, FHGWA-SA-10-006. http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa10006/

[10] "Welcome to Alaska Roundabouts." http://www.alaskaroundabouts.com/mythfact6.html

[11] Assumes the existing vehicle fuel mix of 93% gasoline and 7% diesel, according to Pima Association of Governments.

[12] The TEP traffic signal rate is $.07 kWh, which is assumed to increase with all other electric rates at a rate of 2.4% per year.

[13] Persaud, B.N.; Retting, R.A.; Garder, P.E.; and Lord, D. 2001. Safety effect of roundabout conversions in the United States: empirical Bayes observational before-after study. Transportation Research Record 1571:1-8.

[14] Eisenman, S.; Josselyn, J.; List, G.; Persaud, B.; Lyon, C.; Robinson, B.; Blogg, M.; Waltman, E.; and Troutbeck,R. 2004. Operational and safety performance of modern

roundabouts and other intersection types. Final Report, SPR Project C-01-47. Albany, NY: New York State Department of Transportation.

[15] Bergh,C. op cit.

[16] Luttrell, G.; and Russell, E.R. 2002.Public opinion and traffic flow impacts of newly installed modern roundabouts in the United States. ITE Journal 72:30-32, 37.

[17] Retting, R.A.; Mandavilli, S.; Russell, E.R.; and McCartt, A.T. 2006. Roundabouts, traffic flow, and public opinion. Traffic Engineering and Control 47:268-72

[18] Retting, R.A.; Kyrychenko, S.Y.; and McCartt, A.T. 2007. Long-term trends in public opinion following construction of roundabouts. Transportation Research Record 2019:219-24.